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NATIONAL DAM SAFETY PROGRAM. MANALAPAN LAKE DAM (NJ00293), RARI--ETC(U)
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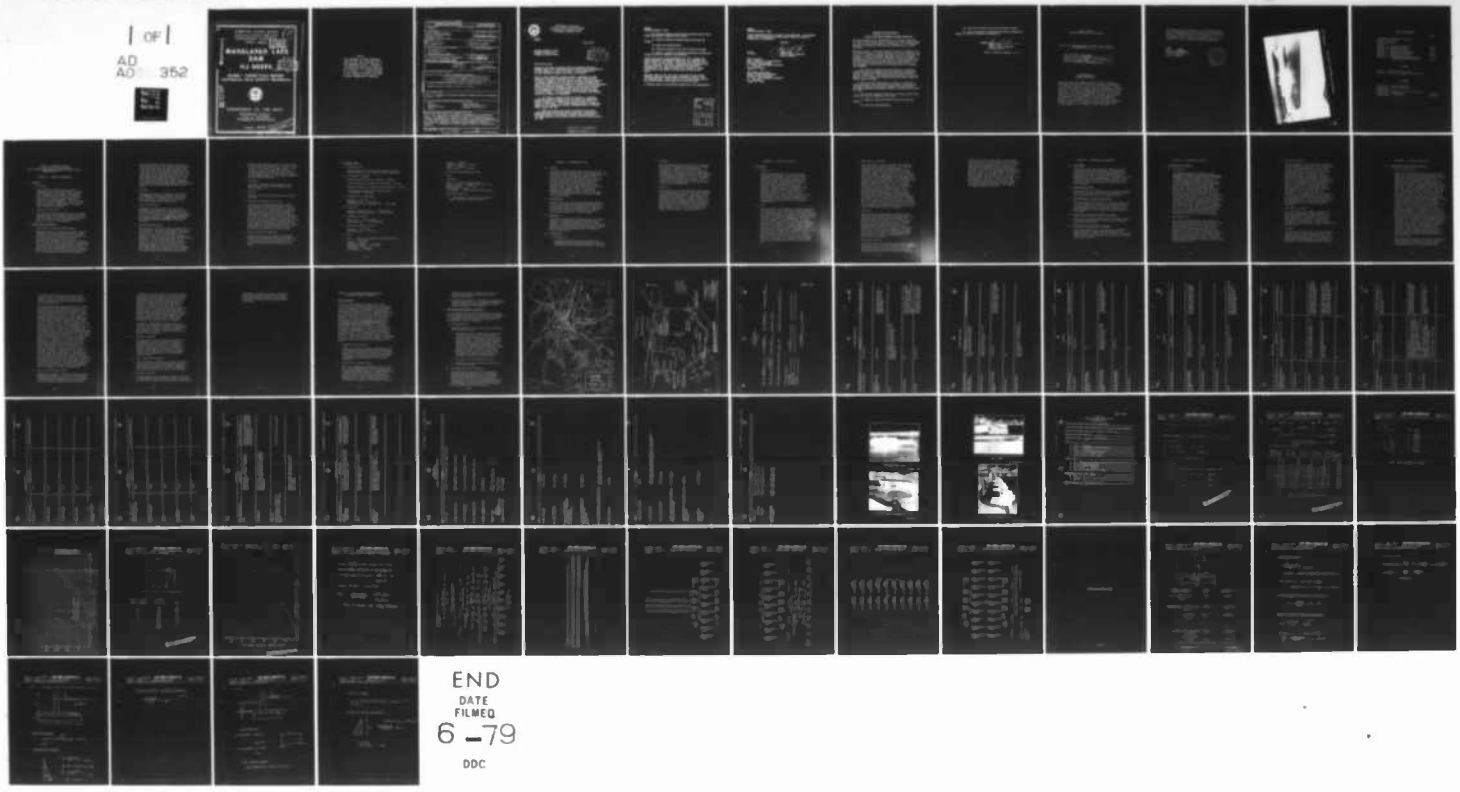

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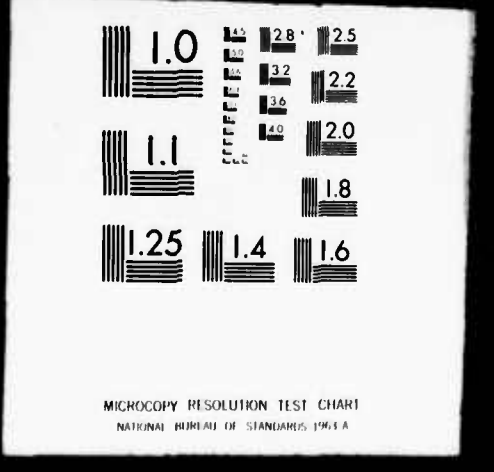

RARITAN RIVER BASIN
MANALAPAN BROOK
MIDDLESEX COUNTY
NEW JEREY

LEVEL II

MANALAPAN LAKE DAM

NJ 00293

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

April, 1979

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

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Embankments
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National Dam Inspection Act
Manalapan Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

24 APR 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Manalapan Lake Dam in Middlesex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Manalapan Lake Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 5 percent of the Probable Maximum Flood (PMF) would overtop the dam. The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the fact that dam failure from overtopping would not significantly increase the hazard to loss of life downstream of the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the structural stability of the spillway, abutments and stilling basin. Any remedial measures found necessary should be initiated within calendar year 1980.

NAPEN-D
Honorable Brendan T. Byrne

c. The following remedial actions should be completed within twelve months from the date of approval of this report:

(1) Remove the deposited granular material from under the bridges.

(2) Repair the inoperable gates.

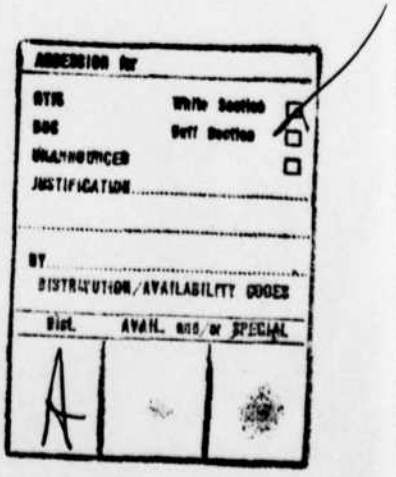
(3) Bring the low points on the top of the dam up to grade.

(4) Develop a checklist of periodical maintenance procedures and maintain a record of conditions and inspections.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Frank Thompson Jr. of the Fourth District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation



NAPEN-D
Honorable Brendan T. Byrne

of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

MANALAPAN LAKE DAM (NJ00293)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 7 December 1978 by Louis Berger Associates, Inc. under contract to the State of New Jersey. The state, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Manalapan Lake Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 5 percent of the Probable Maximum Flood (PMF) would overtop the dam. The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the fact that dam failure from overtopping would not significantly increase the hazard to loss of life downstream of the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

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(2) Repair the inoperable gates.

(3) Bring the low points on the top of the dam up to grade.

(4) Develop a checklist of periodical maintenance procedures and maintain a record of conditions and inspections.

APPROVED: _____
JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 24 June 1969

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Manalapan Lake Dam Fed. ID# NJ 00293, NJ ID# 28-57

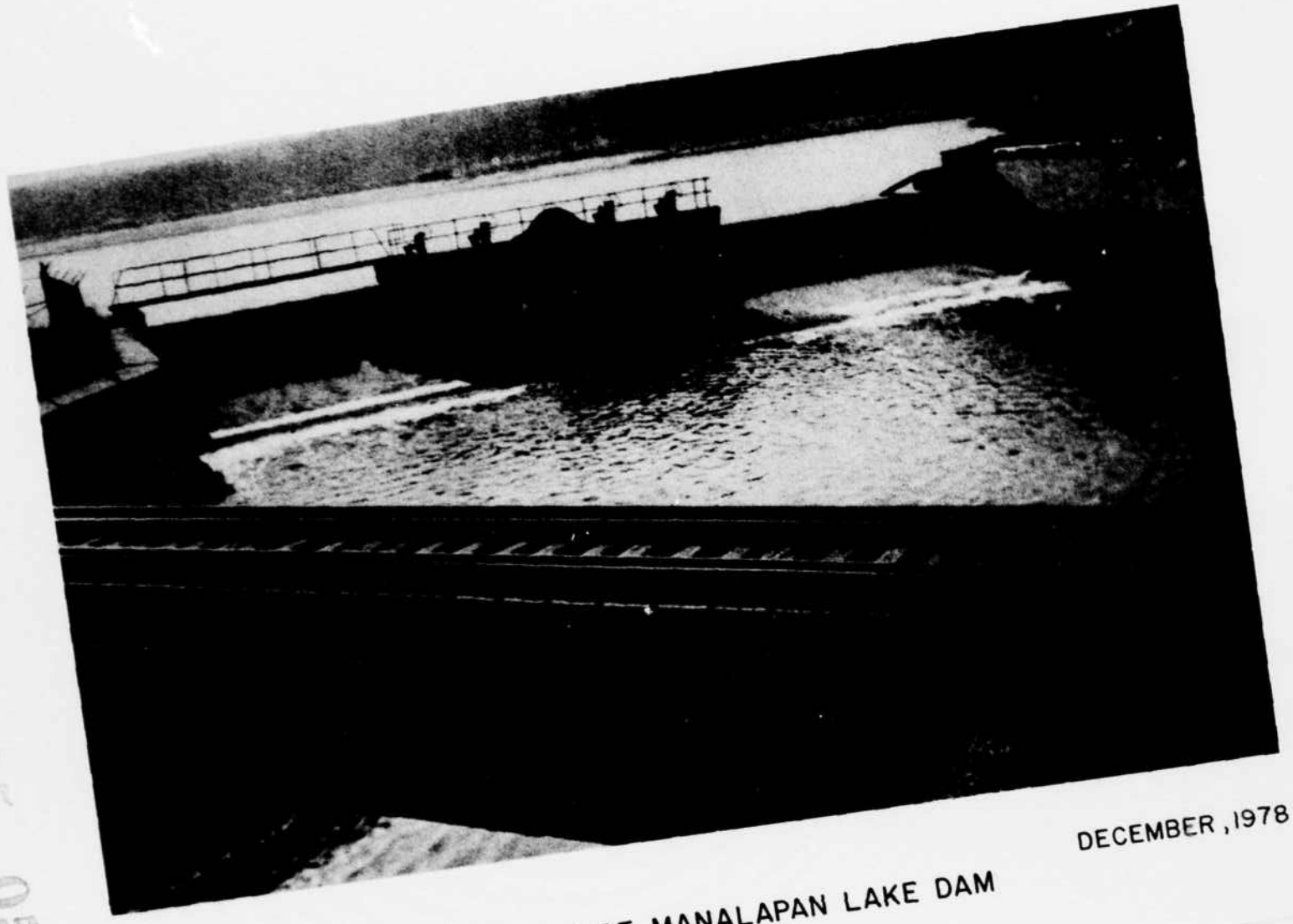
State Located New Jersey
County Located Middlesex
Coordinates Lat. 4020.8 - Long. 7426.1
Stream Manalapan Brook
Date of Inspection 7 December 1978

ASSESSMENT OF GENERAL CONDITIONS

Manalapan Dam is assessed as being in a fair overall structural condition although the spillway is inadequate. The embankment portion is of minor consideration at this site and the concrete spillway and gate structure, although almost 70 years old, has been repaired and functions satisfactorily. Sufficient engineering data was not available regarding the spillway foundations to allow a full assessment of its long term adequacy and further studies are recommended to be undertaken in the future. Remedial actions to be undertaken in the future include 1) the further inspection and repair of the irregular downstream stilling basin 2) the repair of inoperable gates, and 3) the regrading of low points in the dam crest.

The capacity of the spillway will accommodate only 4% of the design flood but the dam is not assessed as UNSAFE, NON-EMERGENCY as it does not comply with the provisions of ETL 1110-2-234. However, it is recommended that it retain its high hazard classification due to its position within the community.

F. Keith Jolls P.E.
Project Manager



OVERVIEW OF MANALAPAN LAKE DAM

DECEMBER, 1978

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: MANALAPAN LAKE DAM FED ID# NJ 00293
NJ ID# 28-57

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia, to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Manalapan Lake Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Manalapan Dam is a concrete and earth structure containing two spillways separated by a gate structure. The earthen portions of the dam are very shallow fills contiguous with and at the same elevation as the surrounding terrain. The embankment is partially protected by a reinforced concrete wall along its upstream face, which is 2 feet above spillway crest. The right and left concrete spillways are 27 feet and 32 feet long respectively and are separated by the 41-foot long, concrete sluice-gate housing. The buttressed gate section contains

five 48" diameter, steel lined sluices with stem operated, cast iron gates on the upstream face. The spillways and gates discharge onto a 104-foot wide concrete apron which extends a distance of 22 feet below the spillway. The apron and channel immediately downstream are contained by concrete retaining walls on each side which range in height from 8.5 to 10.5 feet above the channel bed. These walls form an irregular stilling basin before funneling the flow under railroad and highway bridges whose abutments constrict the channel width to 51 feet.

b. Location

Manalapan Lake Dam is located in the Borough of Jamesburg, Middlesex County, New Jersey. The dam impounds Manalapan Brook about 150 feet south of its intersection with Route 522 and Forsgate Drive (Route 32).

c. Size Classification

Manalapan Lake Dam is 11.5 feet high and impounds an estimated 297 acre feet of water at maximum pool elevation. Accordingly, this dam is in the small size category as determined by the criteria of the Recommended Guidelines for Safety Inspection of Dams (storage less than 1,000 acre-feet and height less than 25 feet).

d. Hazard Classification

The borough of Jamesburg lies on either side of the Manalapan Lake Dam. Two bridges cross the river channe 150 feet downstream of the dam at the north end of the stilling basin. Two commercial structures are located immediately adjacent to the channel just north of the bridges. Downstream of these buildings the channel opens into a long narrow marshland along the border of which are several dozen private residences below the crest elevation of the dam. These homes are located in three clusters which encroach on the flood plain at distances of 1,000, 3,000, and 6,000 feet downstream.

Further, approximately 2,000 feet downstream from the dam and immediately adjacent to the stream lies a sewage treatment plant. Since failure of the dam could cause extensive property damage and endanger human life, it is recommended that this dam retain a high hazard classification as previously determined by the Corps of Engineers.

e. Ownership

The dam is owned by the Middlesex County Department of Parks, New Brunswick, New Jersey, 08901.

f. Purpose

This dam is utilized solely for recreational purposes.

g. Design and Construction History

A plaque on the downstream facade of the gate structure indicates the dam was first constructed in 1911 by Fredrick L. Buckelew. However, there is no additional information available regarding the original design or construction. Repair work was performed in 1957 which included apron repairs, replacement of retaining walls, grouting, repair of the sluices, gates and controls, and rehabilitation of various other concrete surfaces. After a major washout additional reconstruction was undertaken in 1974 by Middlesex County, which consisted of rebuilding the entire west retaining wall along the stilling basin.

h. Normal Operation Procedures

There are presently no formal operational procedures at Manalapan Lake Dam. However, as a matter of routine, park personnel open the sluice gates when heavy storms occur in order to lower the water elevation in the lake.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area of this dam consists of 25.0 square miles of rural, gently rolling topography.

b. Discharge at Damsite

Maximum recorded flood at damsite - Unknown

Gate capacity at maximum pool elevation - 563 cfs

Spillway capacity at maximum pool elevation - 517 cfs

Total discharge capacity at maximum pool elevation - 1,080 cfs

c. Elevation (ft. above MSL)

Top Dam - +56 MSL
Spillway crest - +54 MSL
Streambed at centerline of dam - +44.5 MSL

d. Reservoir

Length of maximum pool - 4,600 + feet
Length of recreation pool - 3,700 ± feet

e. Storage (acre-feet)

Top of dam - 297 acre-feet
Recreation pool - 136 acre-feet

f. Reservoir Surface (acres)

Top dam - 122 acres
Spillway crest - 39 acres

g. Dam

Type - Earth with concrete gate and spillway structure
Length - 213 feet
Structural height - 15+ feet
Hydraulic height - 11.5 feet
Top Width - Variable
Side Slopes - Unknown

Zoning - Unknown
Impervious Core - Unknown
Cutoff - Unknown
Grout curtain - Unknown

h. Diversion and Regulating Tunnel

None

i. Spillways

Type - 2 Narrow crested weirs
Length of weir - Right - 27'; left - 32'
Crest elevation - +54 MSL
U/S Channel - None
D/S Channel - High-walled stilling basin

j. Regulating Outlets

5 - 48" diameter, steel-lined sluices at invert +45; built into spillway.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No plans or design computations were available relating to the original 1911 construction. The 1957 restoration plan (see Figure 2) was prepared by Mr. Frank H. Lehr PE #9060 and depicts the overall configuration of the spillway structure and the repair work undertaken at that time. In 1974 the Office of the County Engineer prepared plans for the reconstruction of the retaining wall on the west side of the stilling basin (at the corner of Route 522 and the entrance into Thompson Park). These plans indicated the details of the 20 feet high wall, but included neither borings nor design assumptions and analysis.

2.2 CONSTRUCTION

Nothing is known about the construction except that the 1974 work was accomplished substantially in accordance with the contract plans. The 1957 repair work consisted principally of restoration of the sluice gates and stilling basin apron and pressure grouting of leaking joints.

2.3 OPERATION

Hydraulic considerations notwithstanding, the dam appears to be operating satisfactorily from an engineering design standpoint. The most recent wingwall construction has stabilized the previously washed out area between the north abutment of the Penn-Central Railroad bridge and the Thompson Park entrance road.

2.4 EVALUATION

a. Availability

Sufficient engineering data regarding the foundations of the spillway structure was not available to fully assess its design stability.

b. Adequacy

The engineering data relating to the spillway structure is considered inadequate to assess its overall stability with sufficient reliability. Nothing is known regarding the foundations of the gate structure. Additional geotechnical information and structural details of the foundation structure will be required for complete evaluation as will be an investigation of the stilling basin invert (this could not be observed due to high water levels at the time of inspection).

c. Validity

The validity of the 1957 and 1974 repair plans is not questioned. The work undertaken appears satisfactorily engineered in the view of the inspection team and is not challenged insofar as what was constructed. However, there is some reservation regarding design assumptions utilized in the development of the retaining wall plans and its safeguards against scouring and/or undercutting of the spread footings. There appears to be no vertical sheeting in front of the footing. (See Section 6.)

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspections of the study dam were conducted on December 7 and 10, 1978 and a reinspection was made on 21 January 1979 during a period of extreme heavy flow. On the latter date, the dam was functioning adequately with approximately one foot of flow over the crest of the spillways. However, several streets in Jamesburg were closed to traffic due to overflowing culverts along the brook that flows into Manalapan Brook just northeast of the dam and Route 522, and an additional increase in the lake level could have inundated a considerable area of the surrounding street system and buildings within the immediate neighborhood.

b. Dam

Scant appraisal can be made of the dam embankment as there are no true structural backslopes and the lakefront comes right up to the crest shoulder on the upstream side. It appears that approximately 1600 feet of railroad embankment on the east shore originally formed a low embankment, but early records indicate that this has been in place prior to 1876, and its true limits are completely obliterated. Likewise, the west abutment area is basically level with the Thompson Park entrance road at its intersection with Forsgate Drive. Therefore, the only effective embankment portions of the dam are immediately adjacent to the concrete wall sections and along the stilling basin retaining walls. The surfaces of these areas are level and well-graded, although minor erosion was noted at the terminus of the right retaining wall that parallels the axis of the dam.

c. Appurtenant Structures

The two sections of the concrete ogee spillway show some minor surface cracking, but the 1957 shotcreting and gunite repairs appear to be satisfactorily sealing the previously spalled surfaces. There is some spalling on the east spillway abutment and channel wall and a portion of the footing is undermined near the end of the apron slab. The gates appear in a satisfactory condition with the exception of the easterly gate control mechanism which lacks a rack and has chipped teeth in the pinion gear. The hand railing and vandal fencing is in satisfactory condition, with the exception of the portion at the right end which needs repair. The downstream spillway apron is roughly 22 feet in width and is approximately 10 feet below the spillway crest. This was reconstructed in 1957 as a considerable portion had been undercut and broken up. Its present condition is suspect due to the high exit velocities of the 48" gates. The left retaining wall is in excellent condition as it is only a few years old, but the right wall has suffered bad structural cracking which extend clear through the stem in some areas.

d. Reservoir

Lake Manalapan extends approximately one-half mile to the southeast where it passes under the railroad. Both the east and west banks are satisfactorily stabilized (by the railroad on the east and the recreation beach in Thompson Park on the west) but several acres of land immediately surrounding the lake are only slightly more than two to three feet above dam crest and could be easily flooded. The lake bed is old, and, due to the geotechnic makeup of the recent alluvium silts and marine clays prevalent in this area, is believed to be quite heavily silted up.

e. Downstream Channel

The brook below the railroad and highway bridges extends out into a marshy floodplain, and numerous homes have been built right down at the normal flood elevations which would undoubtedly be inundated during periods of extensive flooding.

As verified by local residents, considerable downstream areas on both sides of the riverbed are flooded when the reservoir banks are overtopped, which reputedly, occurs quite often. The extent of damages normally sustained is unknown. Railroad Avenue, which runs parallel and just south of the track below the left abutment is well below the dam crest. The downstream channel has between 6 and 7 feet of headroom under the low steel on the bridges but as reviewed in Section 5, appears to have adequate hydraulic capacity, although there is a large accumulation of sand and gravel immediately under the bridges. This appears to require periodic removal.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures were not observed by the inspection team. The embankment and appurtenant structures are part of the Middlesex County Park Commission's normal operation and maintenance responsibility, but no manuals or instructions for the regulation of flow were available. However, park police regulate the reservoir level during periods of heavy runoff, utilizing the sluice gates at the spillway.

4.2 MAINTENANCE OF DAM

Maintenance of the embankment and spillway structure is carried out by the MCPC. Little maintenance has been required since the 1974 rehabilitation.

4.3 MAINTENANCE OF OPERATING FACILITIES

The five sluice gates were last repaired during the 1957 rehabilitation. Presently, one gate control is lacking a rack for the pinion gear while a second is reputedly difficult to operate. No plans have been formulated for the repair of these facilities at present.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

There is no formal warning system in effect. However, the County Park personnel monitor the dam during periods of heavy flow.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The present operational procedures and safeguards during periods of heavy flow are deemed to be adequate since township and park personnel diligently pursue monitoring activities and reservoir regulation during heavy storms.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

In accordance with the criteria in the Recommended Guidelines for Safety Inspection of Dams, it has been determined that the dam at Manalapan Lake is small in size and in the high hazard category. Accordingly the spillway design flood (SDF) was determined to be the probable maximum flood (PMF). The inflow hydrograph was calculated using precipitation data from Hydrometeorological Report #33. As directed by the Corps of Engineers, the inflow hydrograph and flood routing were performed utilizing the HEC-1 computer program. Peak inflow to the reservoir for the PMF was 24,490 cfs and when routed through the reservoir, reduced insignificantly to 24,310 cfs. The spillway capacity before overtopping occurs is approximately 1,080 cfs. Therefore, the spillway will accommodate only 4% of the SDF. This flood would cause the dam to be overtopped by approximately 4.5 feet, including flow around the ends of the dam for a length of 1,000 feet, the approximate extent of such an overtopping.

b. Experience Data

There is no streamflow data available for this site. Records indicate that the spillway was repaired in 1957 due to general poor condition and not as a result of a failure. Prior to the 1974 work, a portion of the existing west wall along the stilling basin washed out, but there are no records of the flooding conditions which caused this failure. There are no written records of overtopping. Local residents indicate, however, that the dam has been overtopped, although to what extent remains uncertain.

c. Visual Observations

The dam appears to be functioning adequately for most floods, except that due to the small (2 foot) freeboard between spillway crest and the effective top of dam, it is quite easily (and often) overtopped and floods a considerable amount of the low-lying surrounding areas. The bridges, although their soffits are considerably below dam crest, have sufficient hydraulic capacity to pass the normal spillway storm overflows, but could not accommodate the spillway design flood. With a 4-foot head against the railroad bridge (to top of plate girder), the exit canal has an approximate capacity of 5,000 cfs, or 20% of the SDF. The bearings on the railroad bridge are completely rusted away and it is doubtful if this light superstructure could withstand a substantial hydraulic head without being shifted laterally. No high water marks could be observed here or on the 1926 concrete-encased steel girder highway bridge on Route 522.

d. Overtopping Potential

When the design flood (PMF) is applied to the dam, overtopping of approximately 4.5 feet would occur. Furthermore, the dam has been overtopped in the past. Hence the potential for overtopping remains a strong possibility and will have a considerable influence on whatever future work is undertaken at this site.

e. Drawdown

Based upon utilizing four of five sluicegates at full capacity, Manalapan Dam would take approximately 4 hours to dewater. This time would be extended if there is a tailwater condition or the hydraulic characteristics of the sluice gates is impaired at the intake.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Based on the field inspection of the line and grade of the ill-defined dam embankment, its structural stability is believed to be adequate. There are no true embankment zones with hydraulic-induced stress conditions, and the permeability and phreatic parameters would only be discernible immediately adjacent to the spillway. Further, it appears quite possible that the normal groundwater table is only a few feet below the surrounding streets. When the dam is overtopped, most of the extensive low areas which would initially act as emergency spillways are paved streets, particularly Pergola Avenue (extending somewhat perpendicularly northward from the right abutment area) and Railroad Avenue on the west. The damage inflicted on the street system's pavement, curbs, gutters and shoulders by flooding would appear to be much more critical than the potential damage to the dam itself. This condition, however, is inherent in view of the flat topography with respect to the dam's low position and actually has little to do with any hazard condition concerning the dam's collapse. A collapse at the spillway would eventually be contained in the downstream floodplain but could endanger the light (25± tons) railroad bridge superstructure (which could rather easily be laterally displaced). The bridge abutments and their superstructures effectively choke the flood flow so that further damage downstream most probably would consist of a gradual flooding of the low-lying residential areas which are situated well downstream in the flood plain.

The inspection revealed the concrete spillway structure to be structurally sound. There is little evidence of tilting or differential settlement (leading the inspection team

to believe the 68 year-old wall is on some type of piling), and the restoration work appears to be in satisfactory shape although close examination of the submerged critical areas was impossible.

The condition of the narrow 22-foot apron slab and the natural sand and gravel basin in the remainder of the enclosed stilling basin area above the bridges was of major concern. The left retaining wall (built in 1974) is founded on spread footings only 4 to 5 feet below channel invert and could be easily undermined. The structural height of this wall is 20 feet, and with passive earth pressure removed from the toe, the wall has a factor of safety against sliding of only 1.35 to 1.65 (depending on the water level). There is no permanent sheeting driven along the toe of footing according to the design plans. Hence, the continued stability of this wall relies in part on the grouted riprap protection purportedly placed at the toe of the wall. This protection extends out only seven feet from the wall face on a 1:1 slope (to channel invert). It could not be seen in the field. Additionally, there are 24, 48 and 60 inch storm drain pipes that pierce this wall and contribute heavily to the turbulence and scour potential in the stilling basin. As can be seen in Figure 2, the main force of the spillway overflow is directed at the face of this wall and this condition is exacerbated by the fact that the sluice gate at the east end is inoperable so that the two gates at the west end are most often operated, creating a continual clockwise vortex in the stilling basin. This is the cause of the gravel and sand shoal deposited under the east side of the downstream bridges. There is concern over the long-term stability of this condition in the stilling basin.

b. Design and Construction Data

Summarizing Section 2, little is actually known regarding the design, geometry and analytical assumptions made for the original 1911 spillway. It appears that a highway bridge was possibly located immediately downstream from the dam

(connecting Forsgate Drive and Pergola Avenue) in earlier times, but there is little trace of this except some evidence of old timber piling immediately below the spillway apron and the easterly abutment wingwall configuration. Similarly, the railroad bridge may have contained a second set of girders and track south of the present span, but this is also conjectural. All this has only minor bearing on the present conditions except that the original spillway wall may have been buttressed against the downstream bridge abutments, but now the lateral forces are resisted by the retaining walls on each side. These are believed to be adequate for that purpose.

In summary, additional structural data is thought to be required to assess with complete reliance the continued structural stability of the spillway. However, within the scope of this study phase, the structural stability is deemed to be adequate.

c. Operating Records

As previously reviewed, operating records are non-existant. The concrete structure had apparently deteriorated until it required extensive repairs in 1957, and it appears the invert of the stilling basin will require continual maintenance, in some form, in the future. The first gate to the east appears to have been inoperable for a considerable period of time.

d. Post Construction Changes

There have been no further structural modifications since the 1974 construction of the left retaining wall between the spillway abutment and the railroad bridge. The 1974 reconstruction work included no repairs to the spillway.

e. Seismic Stability

The Manalapan Dam is located in Zone 1, and, due to the seismic loading dictated therein, as well as the dam's geometry, has negligible susceptibility

to critical earthquake loading conditions. Experience indicates that dams in Zone 1 will have adequate stability under dynamic conditions if stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ PROPOSED REMEDIAL MEASURES

7.1 DAM ASSESSMENT

Subject to the inherent limitations of the U.S. Corps of Engineers criteria for the Phase I visual inspection, the Manalapan Dam is assessed to be in a moderately satisfactory structural condition, although concern is expressed regarding the continued stability of the stilling basin and west retaining wall between the left spillway abutment and the railroad bridge. The present spillway is inadequate and does not meet the requirements of the Recommended Guidelines for for Safety Inspection of Dams, being able to accommodate only 4% of the SDF as calculated using Corps of Engineers criteria. Although the spillway is inadequate, the dam is not assessed as UNSAFE, NON-EMERGENCY, as dam failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. Little can be presently done to alleviate the continuing overtopping during extreme heavy storms.

a. Adequacy of Information

Except for what was visually observed and the 1974 contract plans, insufficient information was available regarding the spillway and apron structure. No recent surveys have been made. Consequently, additional information will be required to fully evaluate the structural stability.

b. Necessity for Further Study

Due to the high hazard classification and the fact that considerable property damage could be sustained downstream, it is recommended that further engineering studies be undertaken to reliably assess the long-term stability of of the spillway and stilling basin structure. Additionally, in-depth analyses should be considered to ascertain what remedial measures

would be economically feasible to increase the spillway capacity and diminish the flooding potential.

c. No immediate urgency is attached to implementing further studies and it is recommended that the remedial measures enumerated below be taken under advisement in the future.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

It is recommended that further engineering studies be initiated in the future as the dam is classified in the high hazard category, the spillway capacity is inadequate, and the surrounding community is subjected to periodic flooding.

a. Recommendations

Remedial measures to be taken under advisement in the future include:

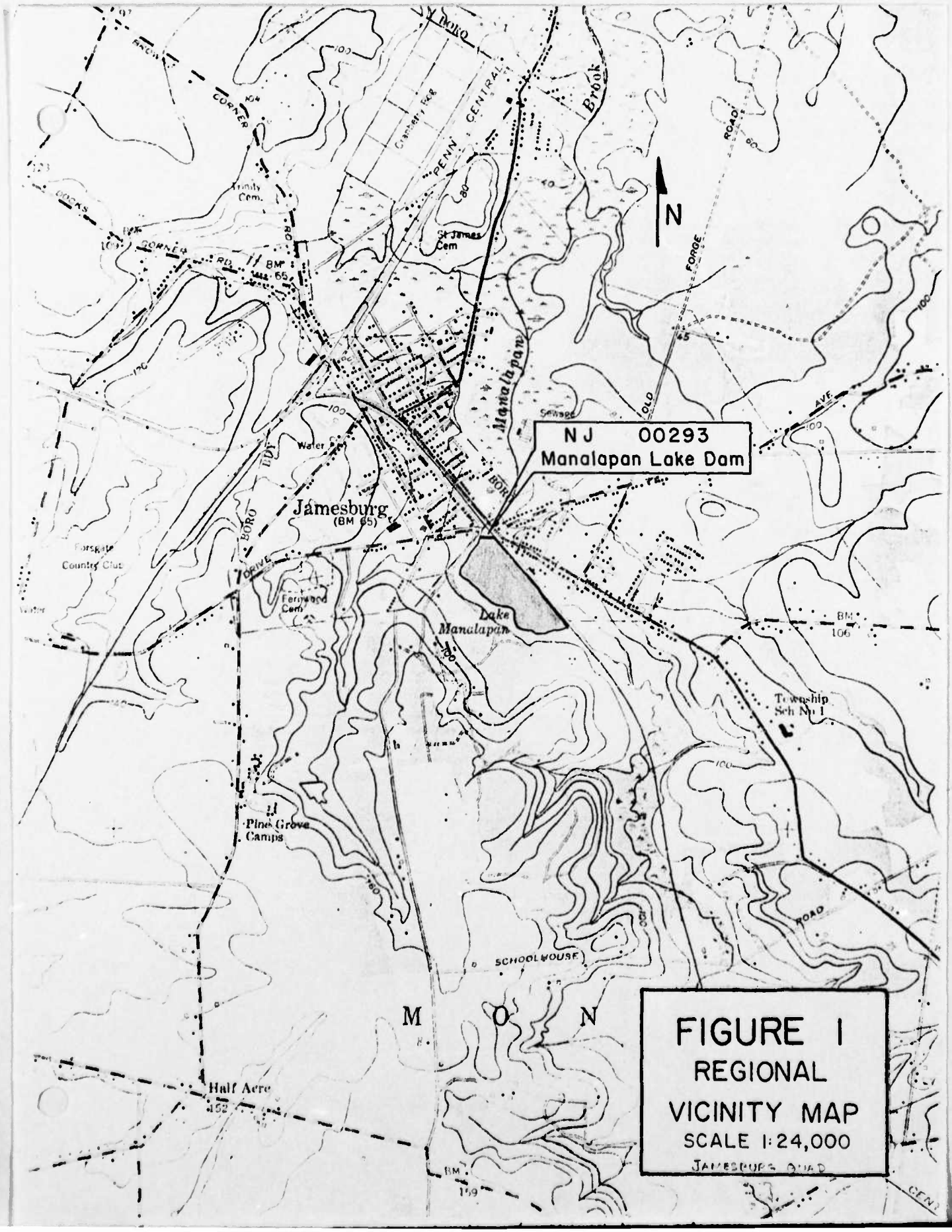
1) Inspection of the condition of the riprap channel protection in the downstream stilling basin and the lower edge of the concrete apron. Although it could not be observed during the inspections, additional scour protection may be dictated. Additionally, the deposited granular material under the bridges should be removed. Based upon conditions observed, it may prove feasible to pave or protect the entire stilling basin area or to install energy deflectors to direct the flows more uniformly towards the bridge opening.

2) The repair of the inoperable gates.

3) Bringing the low points on the top of dam crest up to grade.

b. O&M Maintenance and Procedures

No additional procedures other than those presently being employed by the Middlesex County Park Commission are envisioned that would effectively decrease the flooding potential at this dam. It is recommended that a checklist of periodic maintenance procedures be developed so that records of inspections and conditions can be maintained.


NJ 00293
Manalapan Lake Dam
N
Jamesburg
(BM 65)
Lake Manalapan
Manalapan
Penn Central
Pine Grove Camps
Half Acre
SCHOOLHOUSE
M O N
FIGURE 1
REGIONAL
VICINITY MAP
SCALE 1:24,000
JAMESBURG QUAD

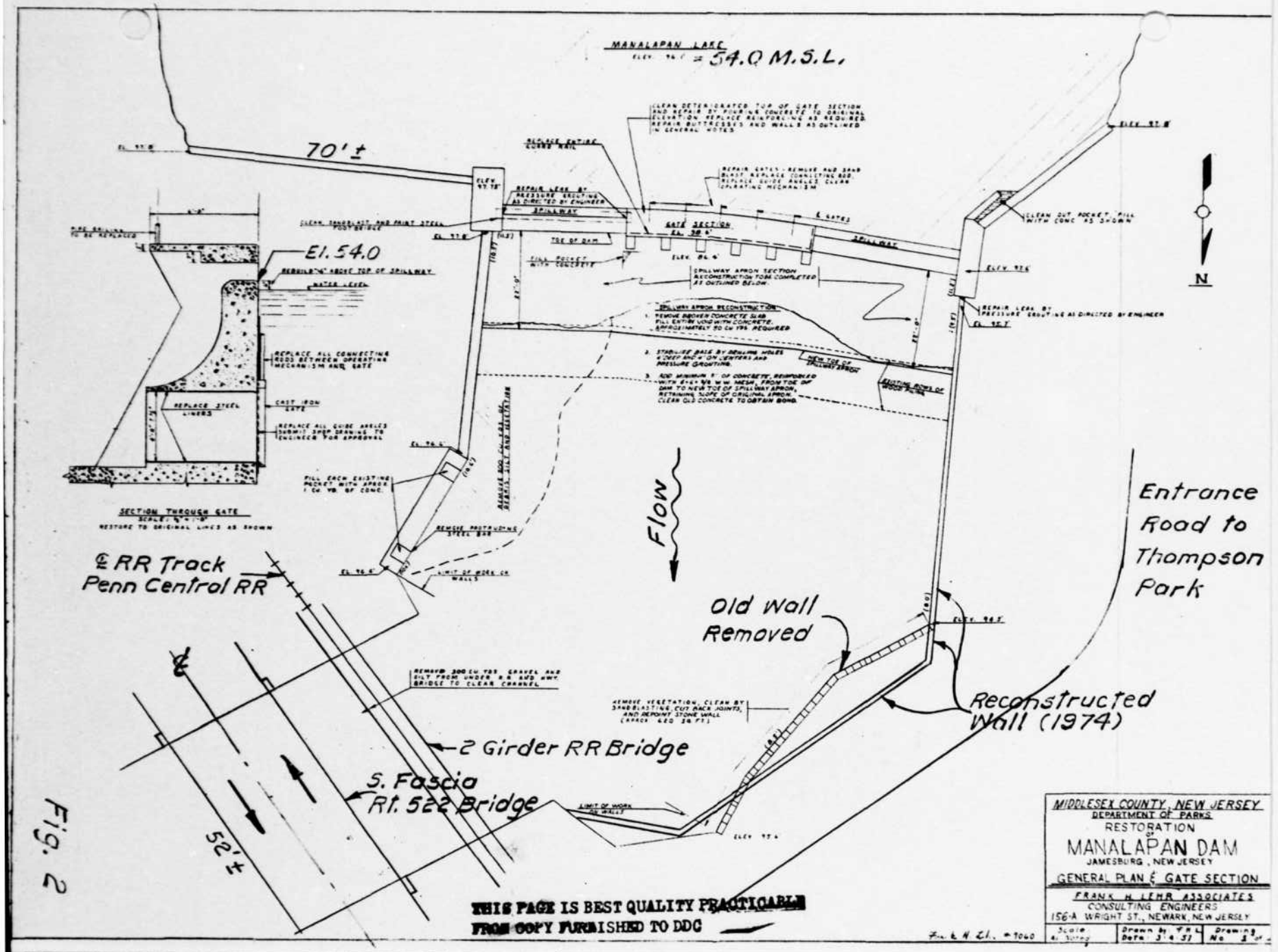


Fig. 2

MIDDLESEX COUNTY, NEW JERSEY
DEPARTMENT OF PARKS
RESTORATION OF
MANALAPAN DAM
JAMESBURG, NEW JERSEY
GENERAL PLAN & GATE SECTION

FRANK H. LEHR ASSOCIATES
CONSULTING ENGINEERS
156-A WRIGHT ST., NEWARK, NEW JERSEY

Scale 1" = 30'-0" | Drawn by F.H.L. | Date 3-14-51 | Drawing No. 1 of 2

Check List
Visual Inspection
Phase 1

Name Dam Manalapan County Middlesex State New Jersey Coordinators NJDEP

Date(s) Inspection 12/7,10/78 & 1/20/79 Weather Clear Temperature 45°

Pool Elevation at Time of Inspection 54.2 M.S.L. Tailwater at Time of Inspection 44.4 M.S.L.

Inspection Personnel:

Tom Chapter E. Simone

Chhoeur Chhut

K. Jolls

Tom Chapter Recorder

Dam No. 00293

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEE PAGE ON LEAKAGE	None observed	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Satisfactory	Abutments repaired (1957). Minor erosion at junction of right retaining wall and reservoir bank.
DRAINS	None at spillways - 60" CCP storm drain through northerly retaining wall. 24" embankment drain through northerly retaining wall.	
WATER PASSAGES	Good	Apron repaired 1957. Junctions of walls, apron and structures look good. Light surface cracking and vertical efflorescence noted.
FOUNDATION	Not observed	Retaining wall on right side of basin exhibits undermined slab at invert level of the apron.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Minor cracking and light spalling an easterly abutment and channel wall.	
STRUCTURAL CRACKING	Possible structural cracking right retaining wall of basin.	
VERTICAL AND HORIZONTAL ALIGNMENT	Satisfactory	No differential settlement noted of spillway structure. Embankment retaining walls appear level.
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	Cold joint noted in retaining wall of stilling basin. No movement noted along joint.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	N/A	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion at junction of right upstream face retaining wall and shoreline of lake.	Right and left abutting shorelines overtopped during periods of heavy flows per locals.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Satisfactory	
RIPRAP FAILURES	N/A	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Appears in satisfactory condition. Minor spalling of concrete.	Prior leaks at abutment junctions were grouted during 1957 repairs and junctions now appear secure.
ANY NOTICEABLE SEEPAGE	None observed	
STAFF GAGE AND RECORDER	None	
DRAINS	Large diameter drains high on left wall of stilling basin.	Light flows emanating from surrounding soils. Heavy flows might cause scouring at toe of wall as no protection has been provided. No protection is visible.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Slight deterioration of concrete at exit invert of sluice gate.	Minor repointing necessary.
INTAKE STRUCTURE	N/A.	
OUTLET STRUCTURE	Five gates located between spillways. Gate structure in satisfactory condition.	Concrete gate structure and gates were repaired in 1957. Controls to most easterly gate lacking rack and teeth in pinion gear chipped.
OUTLET CHANNEL	Gates and spillways discharge into same stilling basin.	Channel retaining walls exhibit light surface cracking and vertical efforescence. Foot of right wall has a severely undermined slab which may have been an older apron.
EMERGENCY GATE	N/A	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIRS	Appear to be in satisfactory condition.	Heavy algal growth on crest of left spillway.
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	Stilling basin good. Discharge channel constricted by existence of railroad and highway bridges. Downstream channel below road bridge is natural, constricted to 25' width at approximately 40 m downstream. Approximate height of channel wall 8-10' - slope 1:1.	Heavy build up of sand and gravel in channel under bridges. Should be cleared and channel deepened.
BRIDGE AND PIERS	Steel catwalk over easterly spillway approximately 2' above crest anchored on West end to gate structure and supported by concrete slab at East abutment. Concrete piers appear in good shape.	Downstream bridges severely constrict discharge capacity of channel.

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Extremely flat - immediate surrounding areas slightly more than 2' above water level of pond.	Slightest rise in water elevation in reservoir results in inundation of surrounding areas. This observation confirmed by communication with Park Engineer.
SEDIMENTATION	None observed. However dam was originally built in 1911 and siltation has probably reduced the storage capacity of the lake considerably.	
January 20		
Street to west - parallels R.R. (Railroad Avenue) is about at dam crest elevation would easily flood.		City park and beach on west bank.
	Railroad bridge approximately 50' span. Highway bridge 1926 concrete encased steel girder. Poor condition.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Stilling basin discharge channel constricted to 50+ feet by Railroad and Highway bridges immediately downstream of dam.	Heavy sedimentation under Railroad bridge. Channel partially (1/2) blocked by gravel bar.
SLOPES	Narrow steep channel grading to slightly wider swampy flood plain.	
APPROXIMATE NO. OF HOMES AND POPULATION	Two buildings, one on each side of the channel right at the road bridge. Several dozen homes 1-2 thousand feet downstream on flood plain.	Definite flood damage potential. Could be excessive depending on storm magnitude.

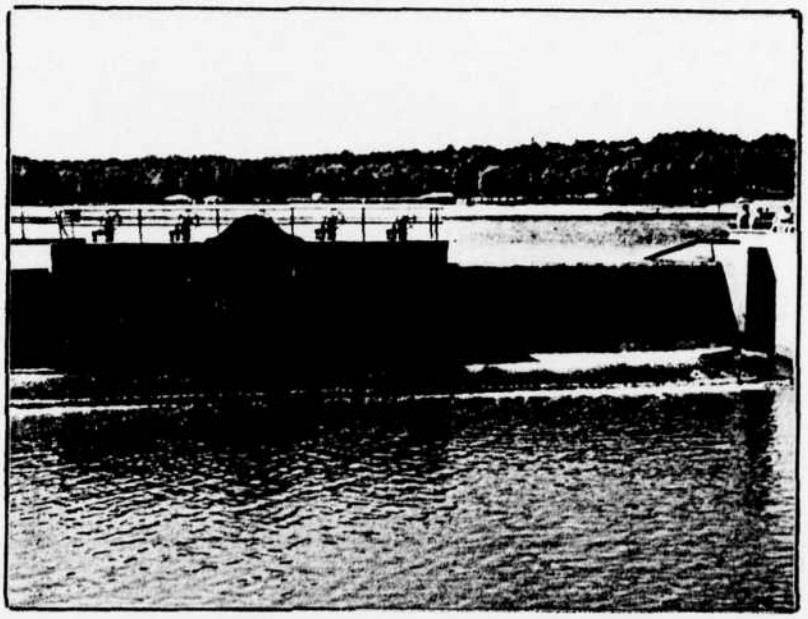
CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Frank H. Lehr Associates, 1957 (NJDEP Records*)
REGIONAL VICINITY MAP	USGS quadrangle, Jamesburg, New Jersey
CONSTRUCTION HISTORY	Built in 1911 by Frederick L. Buckelew
TYPICAL SECTIONS OF DAM	Frank H. Lehr Associates, 1957 (*)
HYDROLOGIC/HYDRAULIC DATA	Not available
OUTLETS - PLAN	Frank H. Lehr Associates, 1957 (*)
- DETAILS	
-CONSTRAINTS -DISCHARGE RATINGS	Not available
RAINFALL/RESERVOIR RECORDS	Not available

ITEM	REMARKS
DESIGN REPORTS	Not available
GEOLOGY REPORTS	Not available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not available
POST-CONSTRUCTION SURVEYS OF DAM	1957 survey performed. Arbitrary datum of 100. Resurveyed 1974, tied to 1957 datum.
BORROW SOURCES.	Unknown

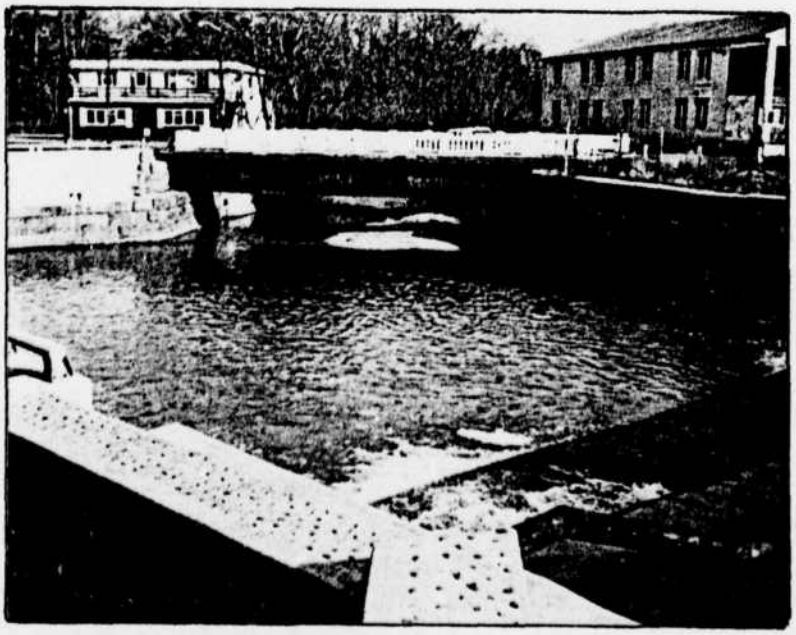
ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	1957 repair plans prepared by Frank H. Lehr Associates. (*) 1974 repairs designed by Middlesex County Engineer.
HIGH POOL RECORDS	Not available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Unknown
MAINTENANCE OPERATION RECORDS	Not available

ITEM	REMARKS
SPILLWAY PLAN	Frank H. Lehr Associates, 1957 (*)
SECTIONS	Frank H. Lehr Associates, 1957
DETAILS	Frank H. Lehr Associates, 1957
OPERATING EQUIPMENT	Frank H. Lehr Associates, 1957
PLANS & DETAILS	Frank H. Lehr Associates, 1957



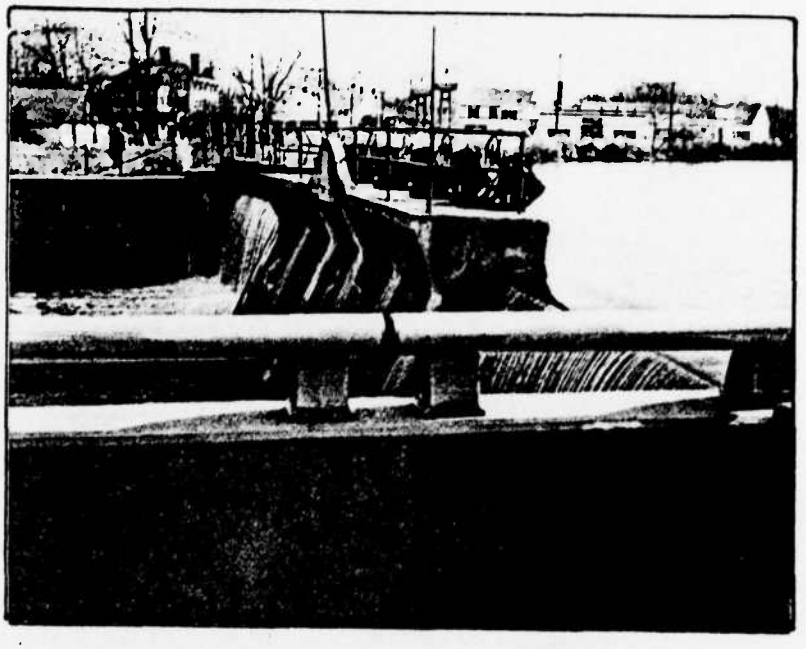
Downstream view of dam

September, 1978



View of bridges downstream from dam

December, 1978



View of spillway

December, 1978

View of sluice gate controls

December, 1978

Dam No. 00293

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 25.0 square-miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 54 M.S.L. (136 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL: 56 M.S.L.

ELEVATION TOP DAM: 56 M.S.L. (297 acre-feet)

CREST:

a. Elevation 54 M.S.L.
b. Type (2) narrow crested ogee weirs
c. Width 2 feet
d. Length 27' on right; 32' on left
e. Location Spillover Center of dam
f. Number and Type of Gates None

OUTLET WORKS:

a. Type Concrete stem operated gate structures w/5.48" ø steel sluices
b. Location Between spillways
c. Entrance inverts 45 M.S.L.
d. Exit inverts 45 M.S.L.
e. Emergency draindown facilities Same

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 1080 C.F.S.

BY D.S.M. DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A1 OF.

CHKD. BY ____ DATE ____ MANALAPAN LAKE DAM INSPECTION PROJECT C227

SUBJECT ____

SNYDER COEFFICIENTS (FROM CORPS OF ENGINEERS)

$C_t = 2.0$

$640\, C_p = 400 \quad \therefore C_p = 0.63$

$T_p = C_t (L L_c)^{0.3}$

$L \approx 14.3$ miles $\quad L_c \approx 7$ miles

$T_p = 2.0\,(7 \times 14.3)^{0.3} \approx 7.96$ hours

Drainage area ≈ 25 Sq miles

Precipitation

PMF for 200 square miles & 24 hours duration = 23"

Maximum 6 hour percentage = 104 %

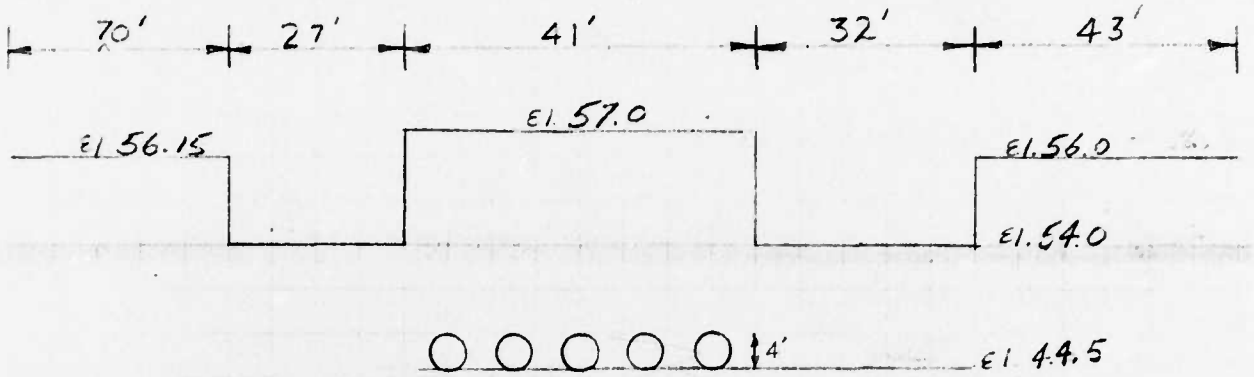
" 12 hour " = 114 %

" 24 hour " = 123 %

BY D.J.M. DATE 12-78 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A2 OF.

CHKD. BY ____ DATE ____ MANALAPAN LAKE DAM INSPECTION PROJECT C227

SUBJECT Spillway discharge



Elevations shown are relative

discharge over crest L = 59'			over dam left L = 70'			Over dam right L = 43'			Over dam middle L = 41'			Through 4 48" sluices (C = 0.57) Q = C a $\sqrt{2gh}$	
H	C	Q	H	C	Q	H	C	Q	H	C	Q	H = 5'	Q = 514
1	3.1	183										6'	563
2	3.1	517										7'	608
3	3.1	950	0.85	2.9	159	1.	2.9	125				8'	650
4	2.9	1369	1.85	2.9	511	2	2.9	353	1	2.9	119	9'	690
5	2.9	1913	2.85	2.9	977	3	2.9	648	2	2.9	336	10'	727
6	2.9	2515	3.85	2.9	1534	4	2.9	998	3	2.9	618	11'	762
7	2.9	3169	4.85	2.9	2168	5	2.9	1394	4	2.9	951	12'	797
8	2.9	3872	5.85	2.9	2877	6	2.9	1833	5	2.9	1329	13'	829
9	2.9	4620	6.85	2.9	3634	7	2.9	2309	6	2.9	1747	14'	860
10	2.9	5411	7.85	2.9	4465	8	2.9	2822	7	2.9	2202	15'	890
11	2.9	6242	8.85	2.9	5345	9	2.9	3367	8	2.9	2690		

tailwater of 5.5' assumed for pipes

BY DJH DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A3 OF.

CHKD. BY ____ DATE ____ MANALAPAN LAKE DAM INSPECTION PROJECT C277

SUBJECT ____

flow over bank

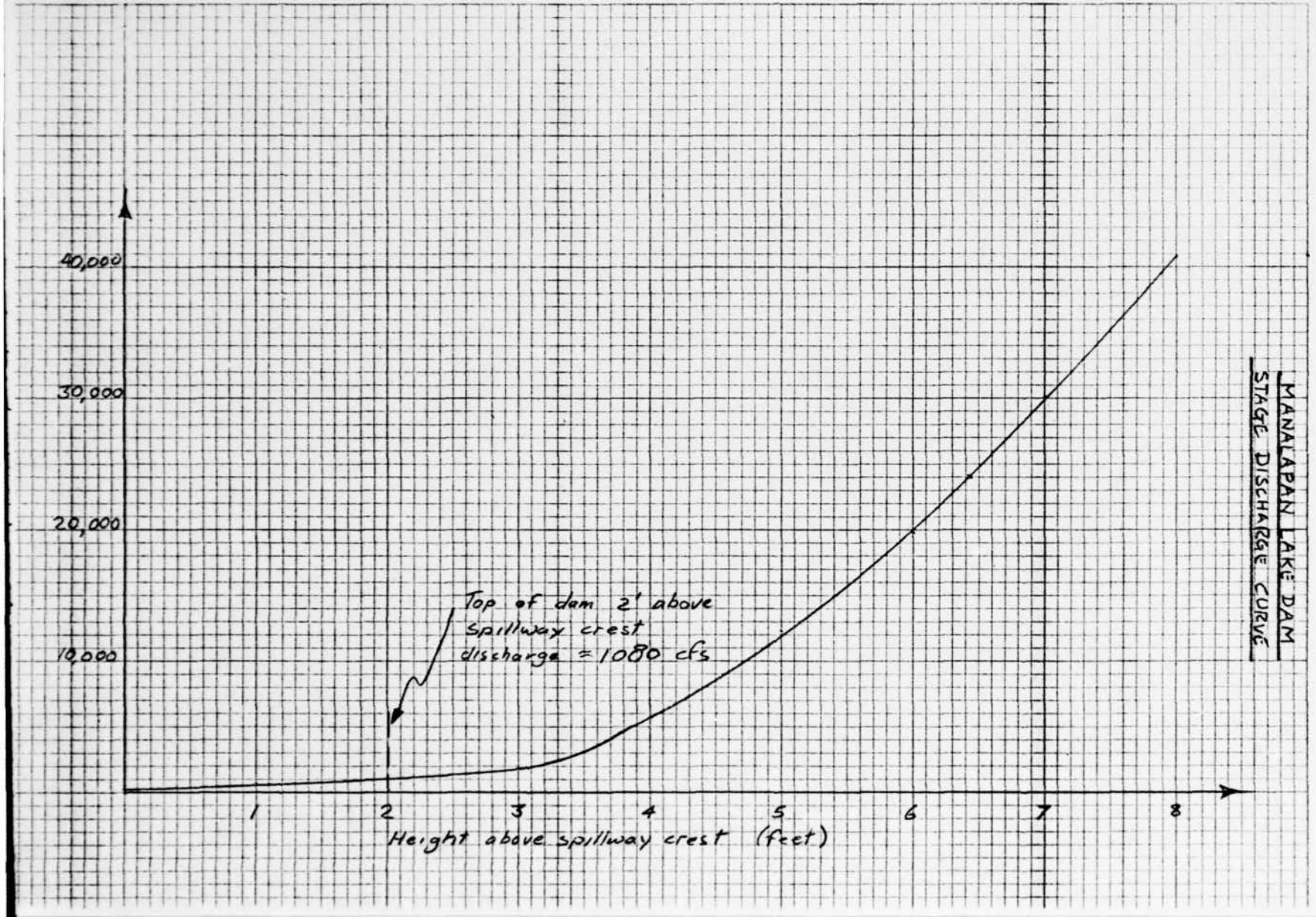
$L = 1000'$

$Q = C a$

H	C	a
1	2.7	2700
2	2.7	7637
3	2.7	14030
4	2.7	21600
5	2.7	30187

H	Q
1	697
2	1,080
3	1,842
4	5,702
5	12,201
6	19,804
7	30,044
8	40,890

Assumes only 4 gates are open



MANALAPAN LAKE DAM
STAGE DISCHARGE CURVE

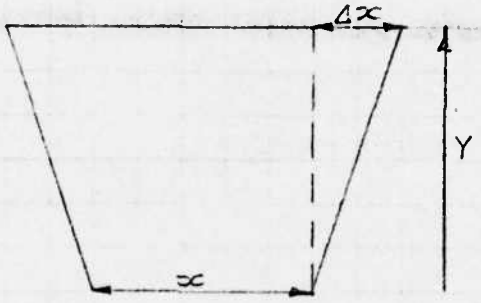
BY. D.J.M DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A5 OF.

CHKD. BY. DATE MANALAPAN LAKE DAM INSPECTION PROJECT C-227

SUBJECT SURCHARGE STORAGE

AREA OF LAKE @ El. 54.0 ≈ 39 acres

AREA OF CONTOUR @ El. 60.0 ≈ 238 acres



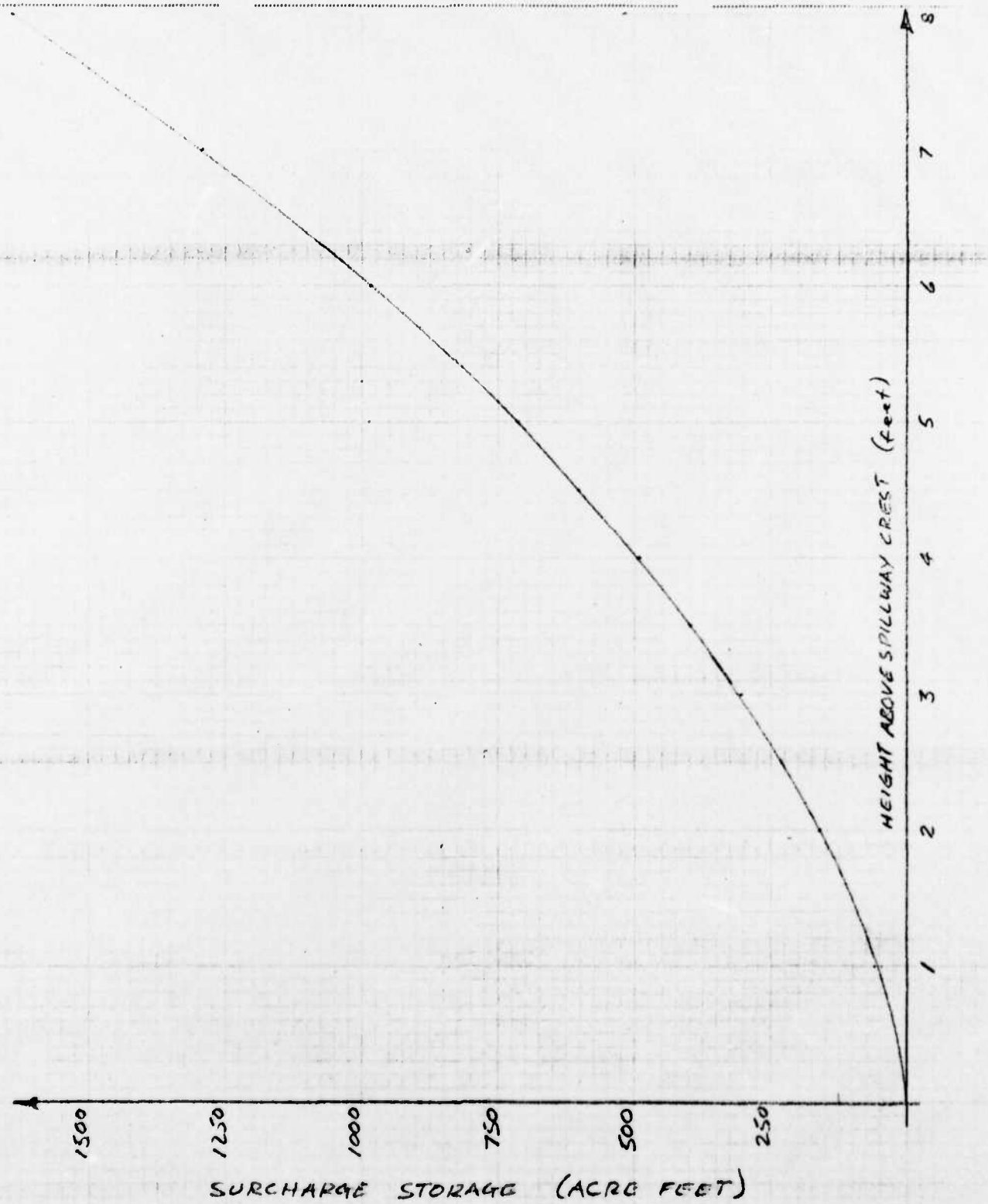
Increment in volume $\Delta V \approx (x + \Delta x) \times y$

HEIGHT ABOVE CREST (feet)	STORAGE (ACRE feet)	EL
1	60	55
2	161	56
3	304	57
4	488	58
5	714	59
6	981	60
7	1290	61
8	1640	62

BY D. J. M DATE 1-79
CHKD. BY DATE

SUBJECT STAGE STORAGE CURVE
MANALAPAN LAKE DAM INSPECTION

SHEET NO. A6 OF
JOB NO. C 227



BY. D.J.M. DATE 4-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A-7 OF

CHKD. BY. DATE MANALAPAN LAKE DAM INSPECTION PROJECT G227

SUBJECT Approximate drawdown calculation

Assume drawdown under average head of 4.5'

Assume inflow of 50 cfs (@ 2 cfs/sq mile)

discharge capacity of pipes = 488 cfs − 50

= 438 cfs

Volume of lake = 136 acre feet

$$\text{time} = \frac{136 \times 43{,}560}{438 \times 3600} = 2.94 \text{ hours}$$

= 3.76 hours

∴ time to drawdown lake = Say 4 hours.

MANALAPAN LAKE DAM INSPECTION NORTH GROUP C227
BY D.J.MULLIGAN
JANUARY 1979

JOB SPECIFICATION

NG	NHR	NMIN	IOAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	1	0	0	0	0	0	0	0	0

JOPER	NWT
5	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1
RTIOS= 1.00 0.50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
4	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	25.00	0.0	25.00	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.00	104.00	114.00	123.00	0.0	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.830

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.50	0.10	0.0	0.0

UNIT HYDROGRAPH DATA
TP= 7.96 CP=0.63 NTA= 0

RECESSION DATA
STRTQ= 0.0 QRCSN= 0.0 RTIOR= 1.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 8.95 AND R= 7.26 INTERVALS

UNIT HYDROGRAPH 44 END-OF-PERIOD ORDINATES, LAG= 7.99 HOURS, CP= 0.63 VOL= 1.00

55.	203.	407.	639.	879.	1088.	1229.	1298.	1280.	1166.
1016.	885.	771.	671.	585.	509.	444.	387.	337.	293.
256.	223.	194.	169.	147.	128.	112.	97.	85.	74.
64.	56.	49.	43.	37.	32.	28.	24.	21.	19.
16.	14.	12.	11.						

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP 0
1	0.11	0.00	0.

LOUIS BERGER & ASSOCIATES INC.
BY DJM DATE
CHKD. BY DATE
SUBJECT MANALAPAN LAKE DAM
SHEET NO. A-8 OF
PROJECT C-227

BY D.J.M. DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

MALVALASAN LAKE DAM

SHEET NO. A-9 OF

PROJECT C-227

2	0.11	0.00	0.
3	0.11	0.00	0.
4	0.11	0.00	0.
5	0.11	0.01	1.
6	0.11	0.01	3.
7	0.32	0.22	19.
8	0.32	0.22	68.
9	0.32	0.22	162.
10	0.32	0.22	307.
11	0.32	0.22	503.
12	0.32	0.22	743.
13	1.99	1.89	1104.
14	2.38	2.28	1746.
15	2.98	2.88	2814.
16	7.54	7.44	4663.
17	2.78	2.68	7509.
18	2.18	2.08	11102.
19	0.17	0.07	15017.
20	0.17	0.07	18783.
21	0.17	0.07	21869.
22	0.17	0.07	23824.
23	0.17	0.07	24492.
24	0.17	0.07	23888.
25	0.0	0.0	22176.
26	0.0	0.0	19885.
27	0.0	0.0	17542.
28	0.0	0.0	15378.
29	0.0	0.0	13470.
30	0.0	0.0	11785.
31	0.0	0.0	10296.
32	0.0	0.0	8984.
33	0.0	0.0	7829.
34	0.0	0.0	6820.
35	0.0	0.0	5941.
36	0.0	0.0	5175.
37	0.0	0.0	4508.
38	0.0	0.0	3927.
39	0.0	0.0	3421.
40	0.0	0.0	2980.
41	0.0	0.0	2596.
42	0.0	0.0	2261.
43	0.0	0.0	1970.
44	0.0	0.0	1716.
45	0.0	0.0	1495.
46	0.0	0.0	1302.
47	0.0	0.0	1134.
48	0.0	0.0	988.
49	0.0	0.0	861.
50	0.0	0.0	750.
51	0.0	0.0	651.
52	0.0	0.0	565.
53	0.0	0.0	490.
54	0.0	0.0	425.
55	0.0	0.0	368.
56	0.0	0.0	319.
57	0.0	0.0	260.
58	0.0	0.0	205.
59	0.0	0.0	152.
60	0.0	0.0	63.
61	0.0	0.0	30.
62	0.0	0.0	7.
63	0.0	0.0	5.
64	0.0	0.0	4.
65	0.0	0.0	3.
66	0.0	0.0	2.
67	0.0	0.0	1.
68	0.0	0.0	0.
69	0.0	0.0	0.

70	0.0	0.0	0.
71	0.0	0.0	0.
72	0.0	0.0	0.
73	0.0	0.0	0.
74	0.0	0.0	0.
75	0.0	0.0	0.
76	0.0	0.0	0.
77	0.0	0.0	0.
78	0.0	0.0	0.
79	0.0	0.0	0.
80	0.0	0.0	0.
81	0.0	0.0	0.
82	0.0	0.0	0.
83	0.0	0.0	0.
84	0.0	0.0	0.
85	0.0	0.0	0.
86	0.0	0.0	0.
87	0.0	0.0	0.
88	0.0	0.0	0.
89	0.0	0.0	0.
90	0.0	0.0	0.
91	0.0	0.0	0.
92	0.0	0.0	0.
93	0.0	0.0	0.
94	0.0	0.0	0.
95	0.0	0.0	0.
96	0.0	0.0	0.
97	0.0	0.0	0.
98	0.0	0.0	0.
99	0.0	0.0	0.
100	0.0	0.0	0.
SUM	23.45	21.01	337357.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	24492.	22689.	12845.	4686.	337356.
INCHES		8.44	19.12	20.92	20.92
AC-FT		11257.	25491.	27895.	27895.

HYDROGRAPH AT STA 4 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	1.	3.	19.	68.	162.	307.
503.	743.	1104.	1746.	2814.	4663.	7509.	11102.	15017.	18783.
21869.	23824.	24492.	23888.	22176.	19885.	17542.	15378.	13470.	11785.
10295.	6984.	7829.	6820.	5941.	5175.	4508.	3927.	3421.	2960.
2596.	2261.	1970.	1716.	1495.	1302.	1134.	988.	861.	750.
651.	565.	490.	425.	368.	319.	260.	205.	152.	63.
30.	7.	5.	4.	3.	2.	1.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	24492.	22689.	12845.	4686.	337356.
INCHES		8.44	19.12	20.92	20.92

BY D J M DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

MANALAPAN LAKE DAM

SHEET NO. A-11 OF

PROJECT C-227

AC-FT	11257.	25491.	27895.		27895.

HYOROGRAPH AT STA 4 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	1.	9.	34.	81.	154.
252.	372.	552.	873.	1407.	2332.	3755.	5551.	7508.	9391.
10934.	11912.	12246.	11944.	11088.	9943.	8771.	7689.	6735.	5892.
5148.	4492.	3915.	3410.	2971.	2588.	2254.	1964.	1710.	1490.
1298.	1131.	985.	858.	747.	651.	567.	494.	430.	375.
325.	282.	245.	212.	184.	159.	130.	103.	76.	32.
15.	3.	3.	2.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	12246.	11345.	6423.	2343.	168677.
INCHES		4.22	9.56	10.46	10.46
AC-FT		5628.	12746.	13947.	13947.

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HYDROGRAPH ROUTING

```
ROUTING THROUGH RESERVOIR
          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME
             44       1       0       0       0       0       1
                           ROUTING DATA
                  QLOSS   CLOSS     AVG    IRES   ISAME
                    0.0     0.0     0.0       1       0

          NSTPS   NSTOL     LAG   AMSKK       X     TSK   STORA
              1       0       0     0.0     0.0     0.0      0.
```

STORAGE=	0.	60.	161.	304.	396.	488.	601.	714.	981.	1290.
OUTFLOW=	0.	697.	1080.	1842.	3100.	5702.	8600.	12201.	19804.	30044.

BY D.J.M. DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

MANALAPAN LAKE DAM

SHEET NO. A-12 OF.

PROJECT C-227

STATION 44, PLAN 1, RTIO 1

0.	0.	0.	0.	0.	1.	7.	31.	86.	182.
327.	519.	732.	920.	1358.	2592.	6089.	9483.	13483.	17177.
20635.	23191.	24309.	24171.	22855.	20747.	18488.	16296.	14272.	12494.
10857.	9474.	8293.	7297.	6354.	5527.	4788.	4173.	3635.	3167.
2871.	2552.	2237.	1952.	1772.	1637.	1486.	1333.	1185.	1056.
960.	864.	773.	674.	494.	396.	327.	266.	209.	143.
80.	40.	18.	9.	5.	3.	2.	1.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	0.	0.	1.	3.	7.	16.
28.	45.	69.	119.	213.	359.	503.	629.	759.	889.
1006.	1083.	1117.	1113.	1073.	1009.	935.	858.	787.	724.
672.	628.	589.	550.	513.	482.	456.	434.	415.	398.
379.	356.	333.	312.	291.	266.	237.	208.	181.	155.
129.	104.	80.	58.	43.	34.	28.	23.	18.	12.
7.	5.	2.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
	CFS	24309.	22651.	12802.	4686.	337356.
	INCHES		8.43	19.05	20.92	20.92
	AC-FT		11238.	25406.	27895.	27895.

STATION 44, PLAN 1, RTIO 2

0.	0.	0.	0.	0.	1.	4.	15.	43.	91.
163.	260.	391.	599.	803.	1096.	1798.	4169.	6668.	8502.
10380.	11566.	12149.	12088.	11438.	10389.	9216.	8143.	7185.	6288.
5488.	4768.	4159.	3624.	3157.	2865.	2544.	2230.	1946.	1769.
1634.	1482.	1329.	1182.	1054.	958.	863.	773.	678.	499.
402.	339.	290.	250.	217.	187.	160.	132.	104.	71.
40.	20.	9.	5.	3.	2.	1.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	0.	0.	0.	1.	4.	8.
14.	22.	34.	52.	88.	164.	296.	434.	526.	597.
657.	694.	712.	710.	690.	657.	620.	583.	546.	511.
480.	455.	433.	415.	398.	379.	355.	332.	312.	290.
265.	237.	208.	180.	154.	129.	104.	80.	58.	43.
35.	29.	25.	22.	19.	16.	14.	11.	9.	6.
3.	2.	1.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
	CFS	12149.	11335.	6355.	2343.	168677.
	INCHES		4.22	9.46	10.46	10.46
	AC-FT		5624.	12612.	13947.	13947.

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PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

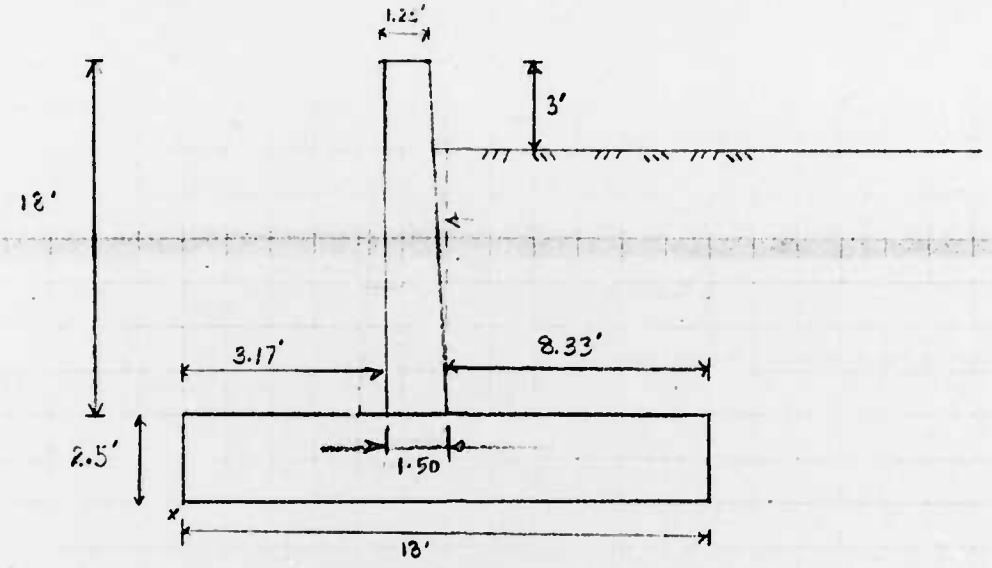
OPERATION	STATION	PLAN	RATIOS APPLIED TO FLOWS 1.00	0.50
HYDROGRAPH AT	4	1	24492.	12246.
		2	5034.	3643.
ROUTED TO	44	1	24309.	12149.
		2	5034.	3643.

STABILITY COMPUTATIONS

BY L E DATE 1-23-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A15 OF

CHKD. BY DATE MANALAPAN DAM PROJECT C-2271

SUBJECT STABILITY ANALYSIS



VERTICAL FORCES	ARM	MOMENT (ABOUT 'x'
FOOTING: 150 #/ft³ x 2.5' x 13' = 4,875	6.5	31,687.5
TAPERED WALL: .25' x 18' x .5 x 150 = 337.5	4.50	1,518.75
1.25' x 18' x 150 = 3,375	3.8	12,825.0
WT. OF EARTH: 8.33' x 15' x 110 #/ft³ = 13,744.5	8.84	121,501.38
.21 x 15' x .5 x 110 = 173.25	4.6	796.95
Σ 22,505.25 lbs		168,329.58 ft-lbs
22.51 k		168.33 ft-k

BY LL DATE 1-23-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A16 OF.

CHKD. BY DATE MANALAPAN DAM PROJECT 227

SUBJECT STABILITY COMPUTATIONS

HORIZONTAL FORCES

$$\frac{110\ ^{\#}/_{ft^3} \times 17.5^2}{2} = 16.84\ K$$

$\phi = 30°$ ∴ COEFF. ACTIVE EARTH PRESSURE = .33

EARTH PRESSURE = $.33 \times 16.84 = 5.56\ K$

MOMENT ABOUT "x" = $5.56\ K \times 5.83 = 32.43\ K\text{-}ft$

FACTOR OF SAFETY AGAINST OVERTURNING

$$F.S. = \frac{168.33}{32.43} = 5.19 \quad ok/$$

FACTOR OF SAFETY AGAINST SLIDING

$\mu = .4$

$$F.S. = \frac{22.51 \times .4}{5.56} = 1.62$$

ECCENTRICITY OF RESULTANT

$$\frac{13}{2} - \left(\frac{168.33 - 32.43}{22.51} \right) = .46 \ll \tfrac{1}{6} \text{ of } 13$$

BY L.B. DATE 1-22-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A-17 OF

CHKD. BY DATE MANALAPAN DAM PROJECT 6-2272

SUBJECT STABILITY COMPUTATIONS

SOIL PRESSURE

$$\text{MAX PRESSURE} = \frac{22.51}{13}\left(1 + \frac{6 \times .46}{13}\right) = 2.10 \text{ K/ft}^2$$

$$\text{MIN PRESSURE} = \frac{22.51}{13}\left(1 - \frac{6 \times .46}{13}\right)$$

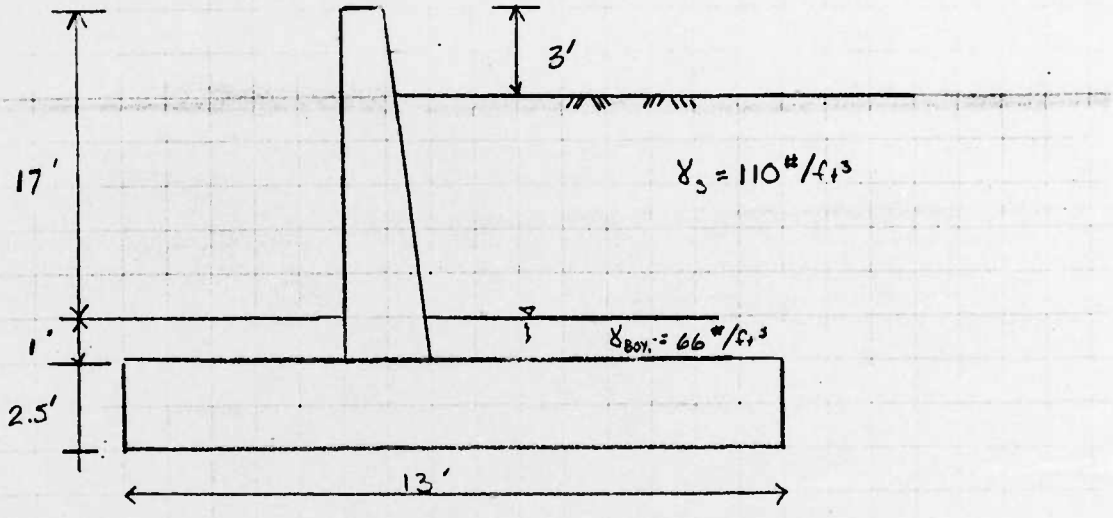
$$= 1.36 \text{ K/ft}^2$$

BY L.E DATE 1-23-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A-18 OF

CHKD. BY DATE MANALAPAN DAM PROJECT C-227

SUBJECT STABILITY COMPUTATIONS

CASE 2 ASSUME 1 FOOT OF WATER ABOVE FOOTING



VERICAL FORCE

$$22.51k - (3.5' \times .0624 \times 13) = 19.67\ k$$

(2.84)

from previous CALC.

HORIZONTAL FORCE

① $\frac{14^2 \times 110 \times .33}{2} = 3.56\ k$

② $3.5 \times 110 \times 14 \times .33 = 1.78\ k$

③ $\frac{66 \times 3.5^2 \times .33}{2} = .13\ k$

$\Sigma = 5.47\ k$

BY L.B. DATE 1-23-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A19 OF

CHKD. BY DATE MANALAPAN DAM PROJECT C-227

SUBJECT STABILITY COMPUTATIONS

FACTOR OF SAFETY AGAINST SLIDING

$\mu = .4$

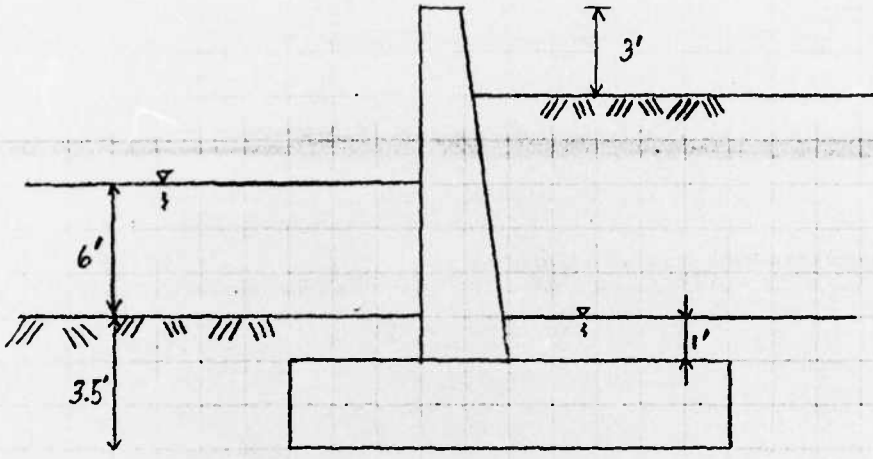
$$\frac{.4\,(19.67)}{5.47} = 1.44$$

BY L.B. DATE 1-23-77 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A20 OF

CHKD. BY DATE MANALAPAN DAM PROJECT G-2277

SUBJECT STABILITY COMPUTATIONS

CASE 3



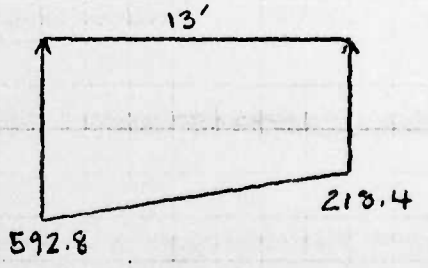
WATER PRESSURE

MAX PRESSURE : $62.4 \times 9.5'$

$= 592.8$ lb/ft²

MIN PRESSURE : $62.4 \times 3.5'$

$= 218.4$



TOTAL UPWARD FORCE

$\frac{1}{2} \cdot 13 (592.8 + 218.4) = 5273$ lbs $= 5.27$ K

BY L.B. DATE 1-23-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A21 O

CHKD. BY DATE MANALAPAN DAM PROJECT C-227

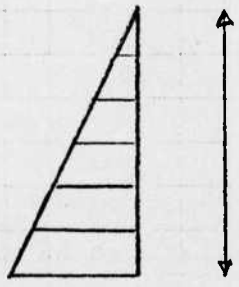
SUBJECT STABILITY COMPUTATIONS

VERTICAL FORCE

$22.51 + (1' \times .110 \times 3.17') - 5.27^{K} = 17.59\ K$

from CASE 1

HORIZONTAL FORCE (LEFTSIDE)



ASSUME $K_{PASSIVE} = 2 \times K_o = .66$

$$\frac{3.5^2 \times 66 \times .66}{2(1000)} = .267\ K$$

$$\frac{.4\ (17.59)}{5.47 - .267} = 1.35$$


DAT
FILM